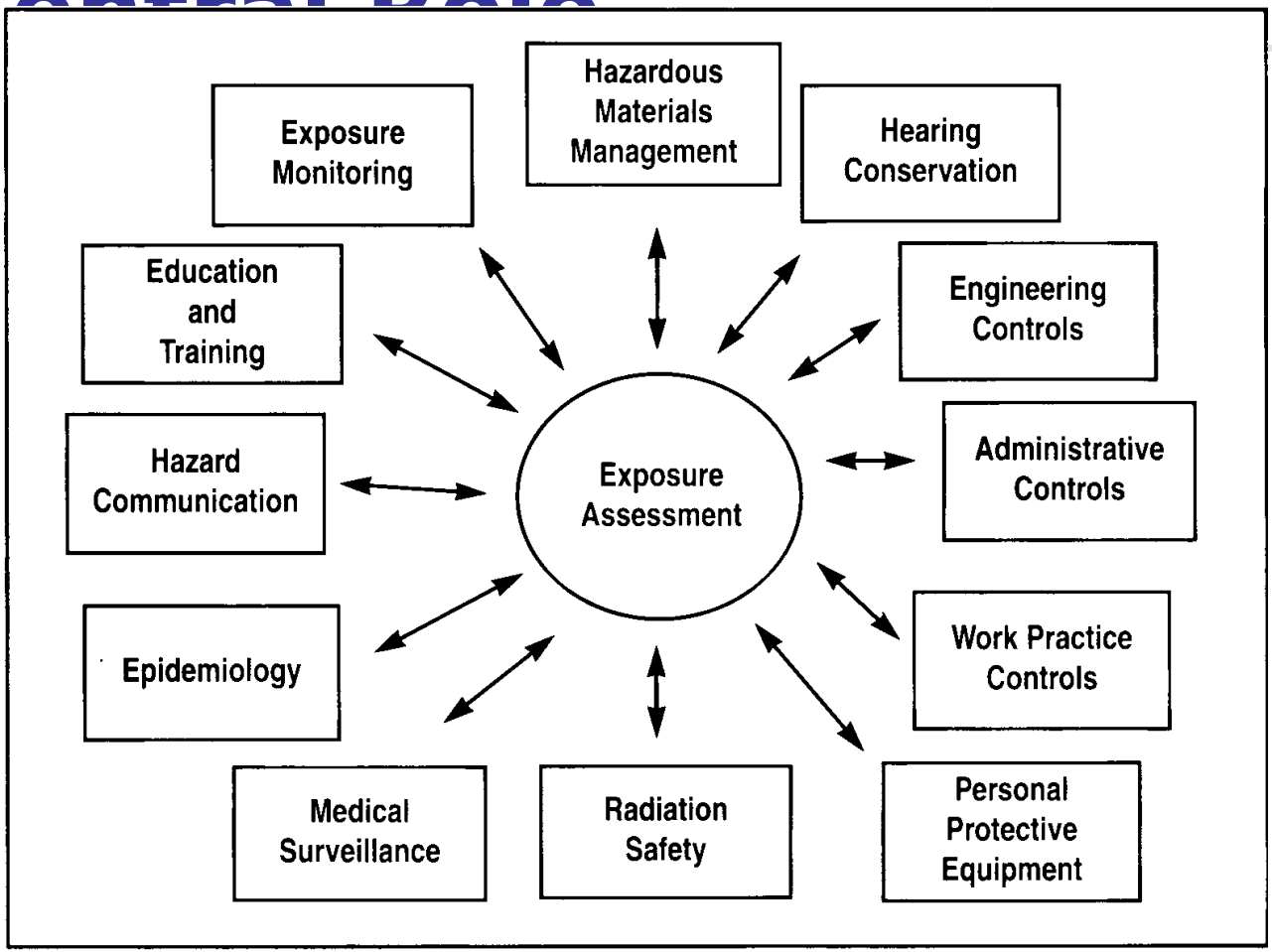
Refining the Exposure Assessment – Decision Making Using Quantitative Data

S. Smallets Jr., MS, CIH

NAVMEDCEN Portsmouth

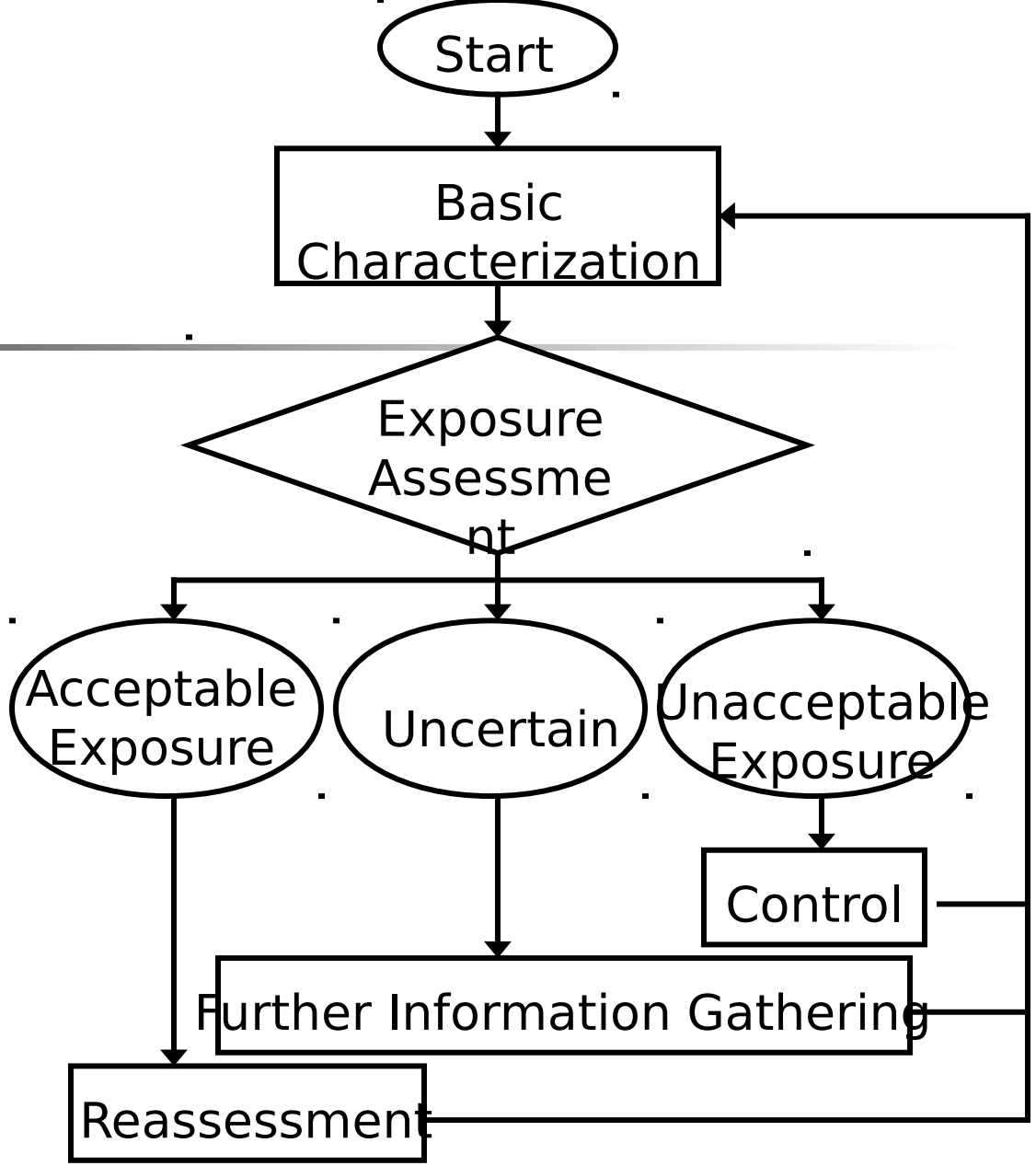
Exposure Assessment's Central Role



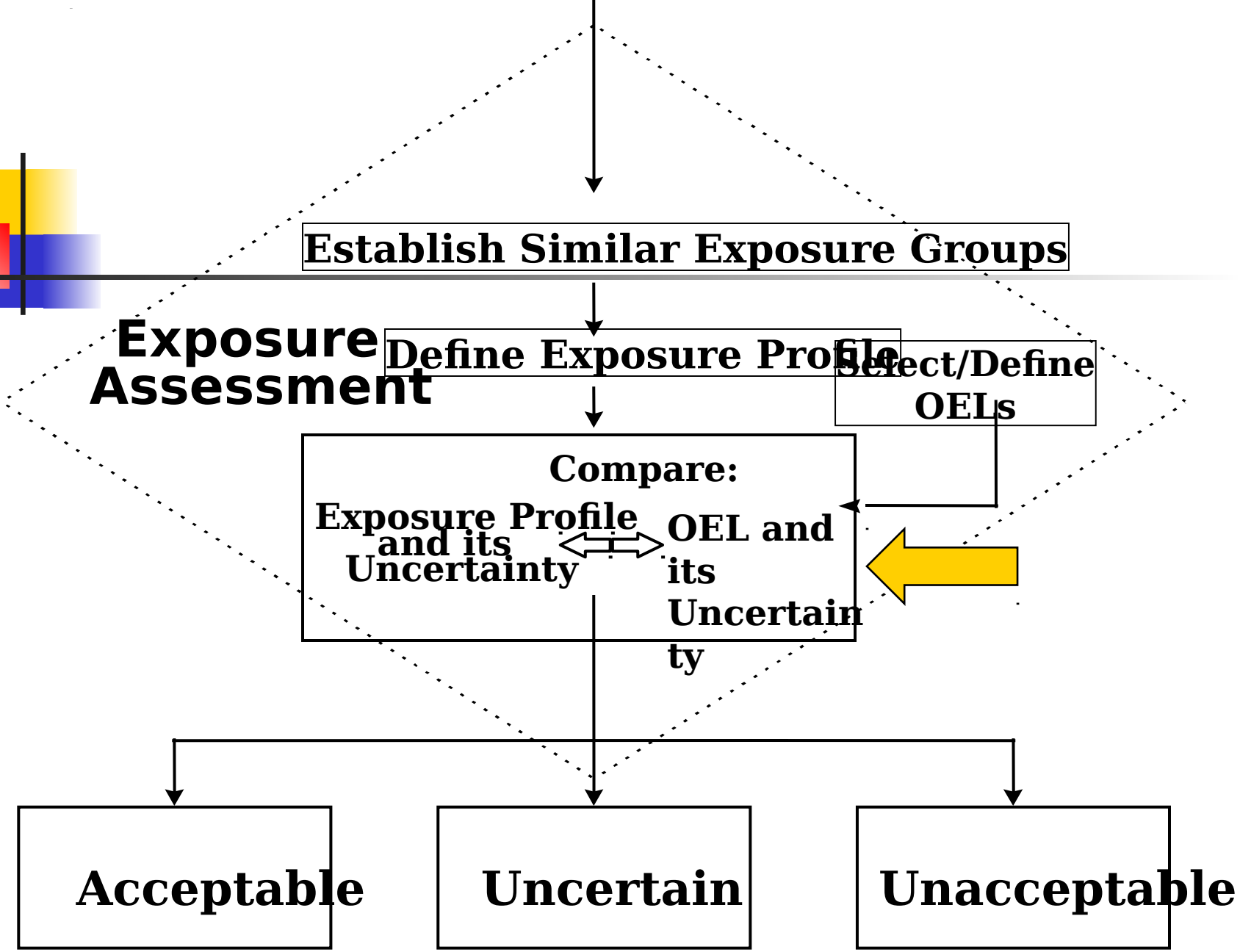
" A Strategy for Assessing and Managing Occupational Exposures" 1998 Fig 1.1 pg 3

AIHA Exposure Assessment Process

OPNAVINST 5100.23F Chapter 8

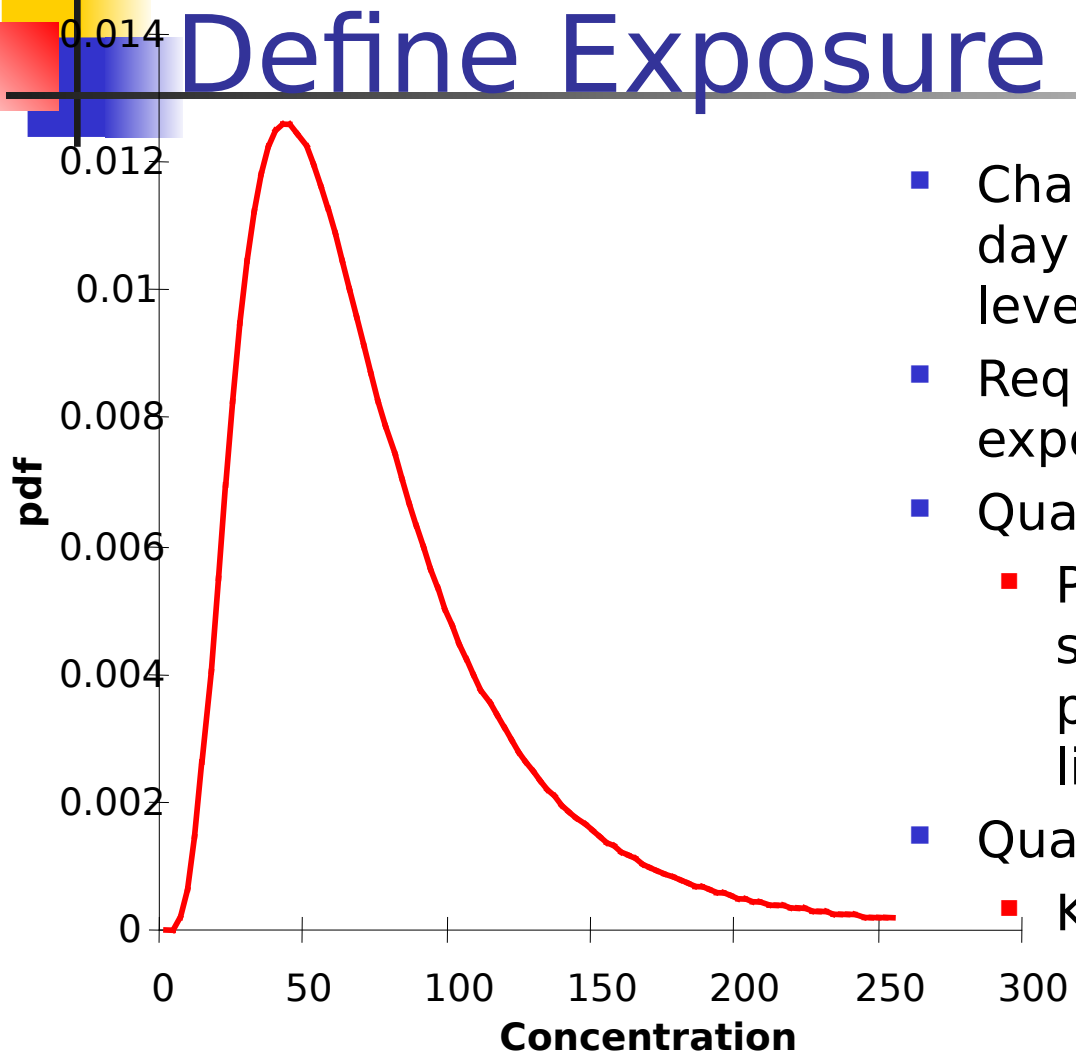


“ A Strategy for Assessing and Managing Occupational Exposures” 1998



"A Strategy for Assessing and Managing Occupational Exposures" 1998

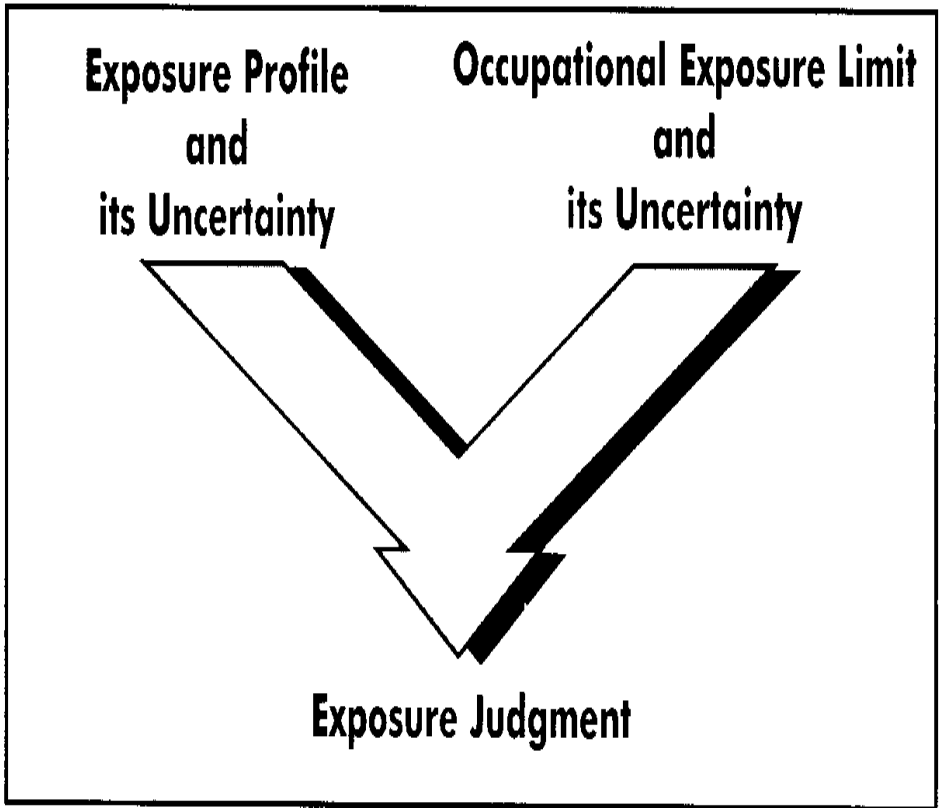
Define Exposure Profile



- Characterization of the day to day variability of exposure levels for a SEG
- Requires an estimate of exposure levels and variability
- Quantitative (6-10 samples)
  - Point estimates i.e. means, standard deviation, percentiles; confidence limits
- Qualitative
  - Knowledge, experience

Judging Exposures

- Following the definition of the exposure profile and selection of OEL
- SEG must be judged acceptable, unacceptable
- Resolved by comparing profile with OEL

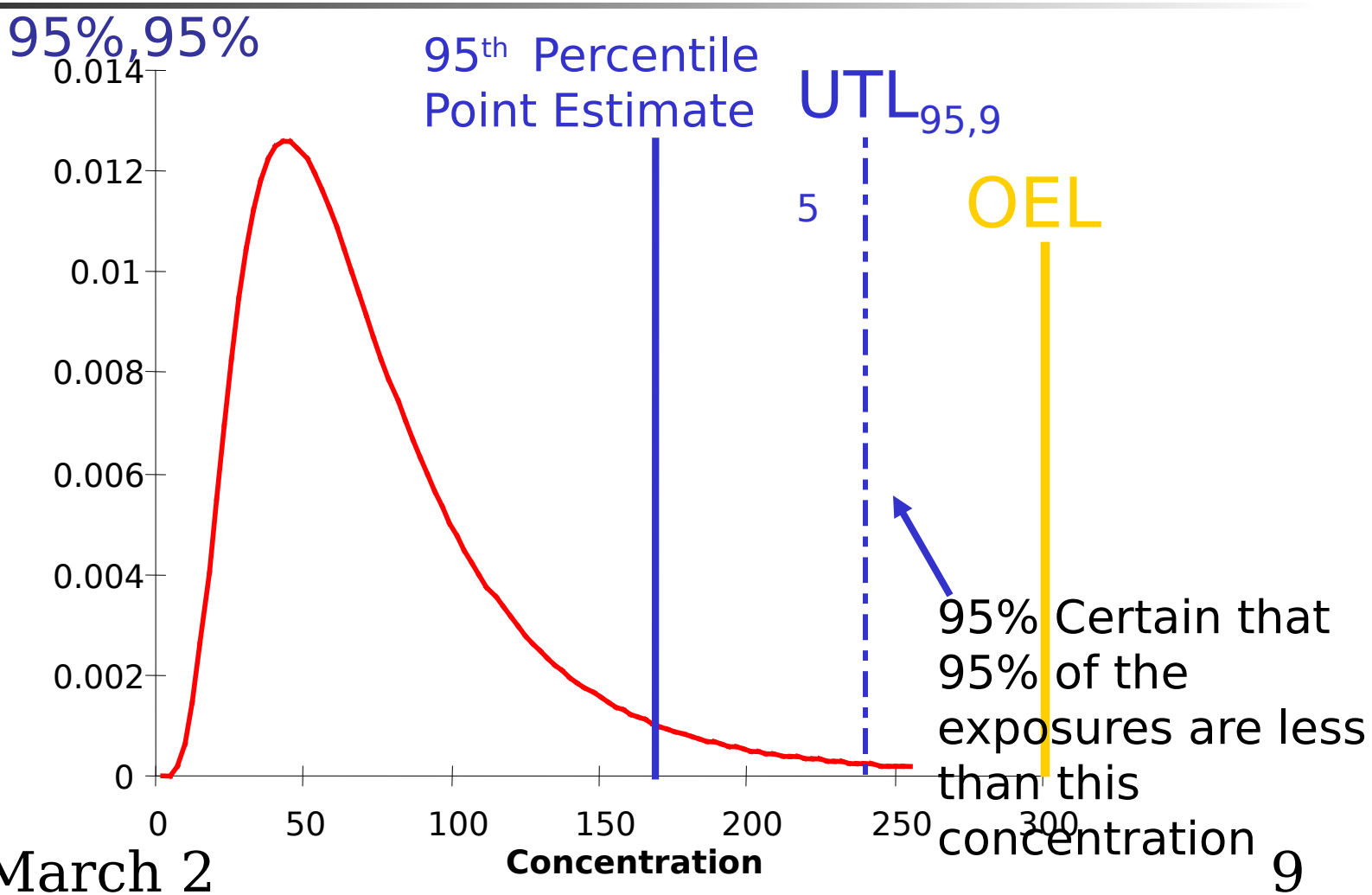


“ A Strategy for Assessing and Managing Occupational Exposure

Criteria for assessing exposures (NIOSH 77-173 "Occupational Exposure Sampling Manual")

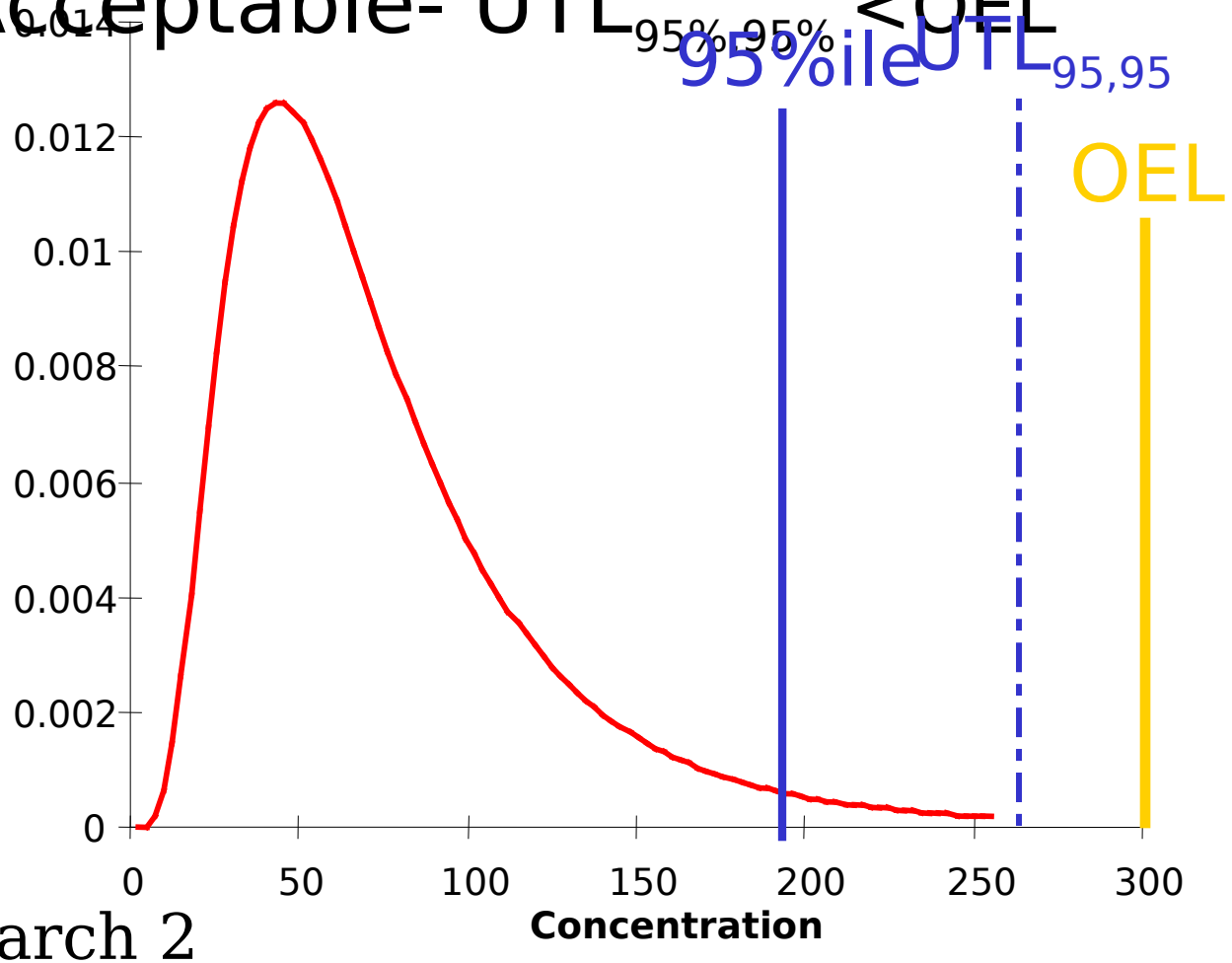
- Employer should have high confidence that a high percentage of exposures are below the standard
- The employer should try to attain 95% confidence that no more than 5% of employee days are over the standard
- Philosophy driving development of 50% Action Level (AL)

Focus on upper tail -- 95th percentile and UTL



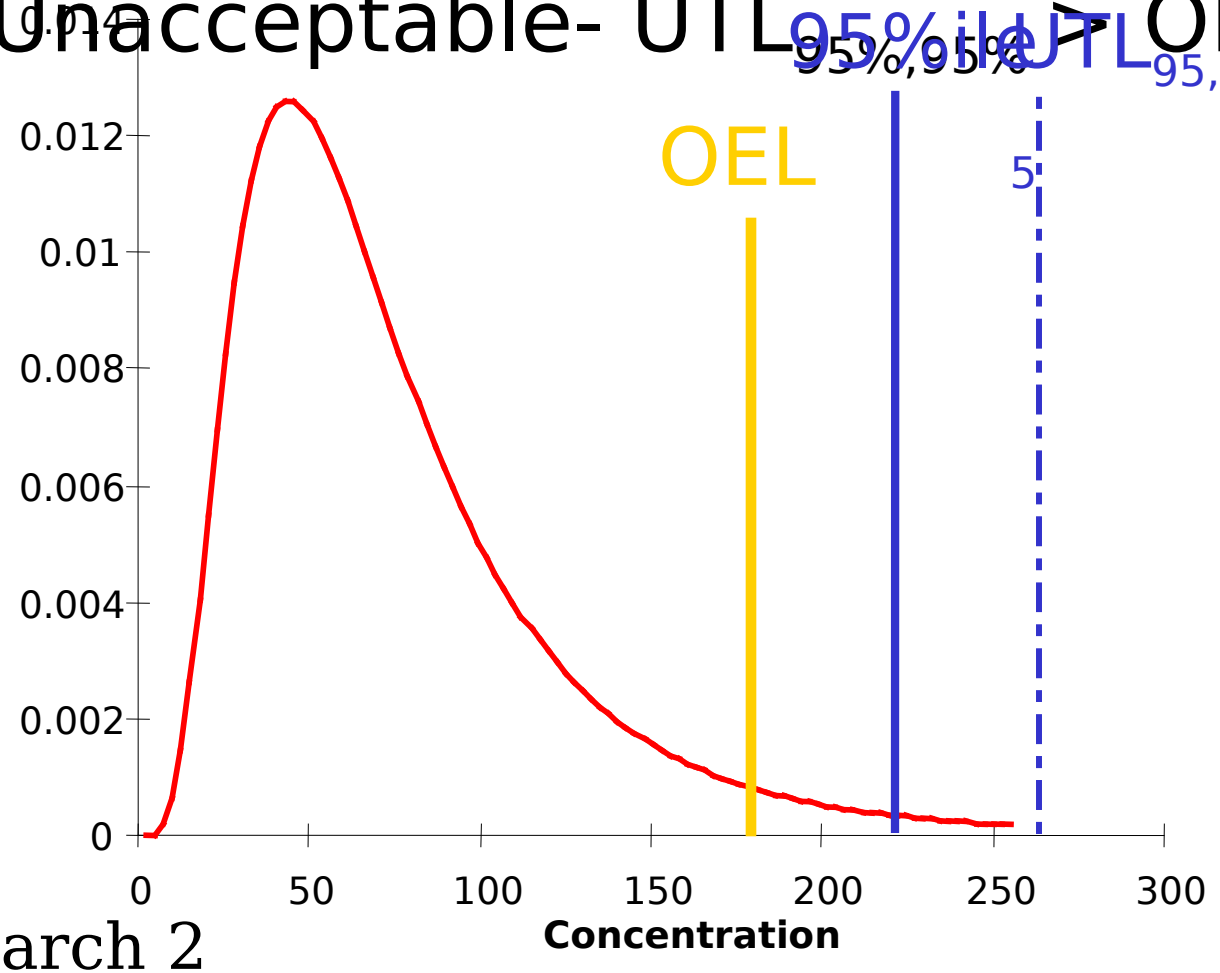
IHFOM Exposure Classifications

Acceptable- $UTL_{95\%,95\%}$ <OEL



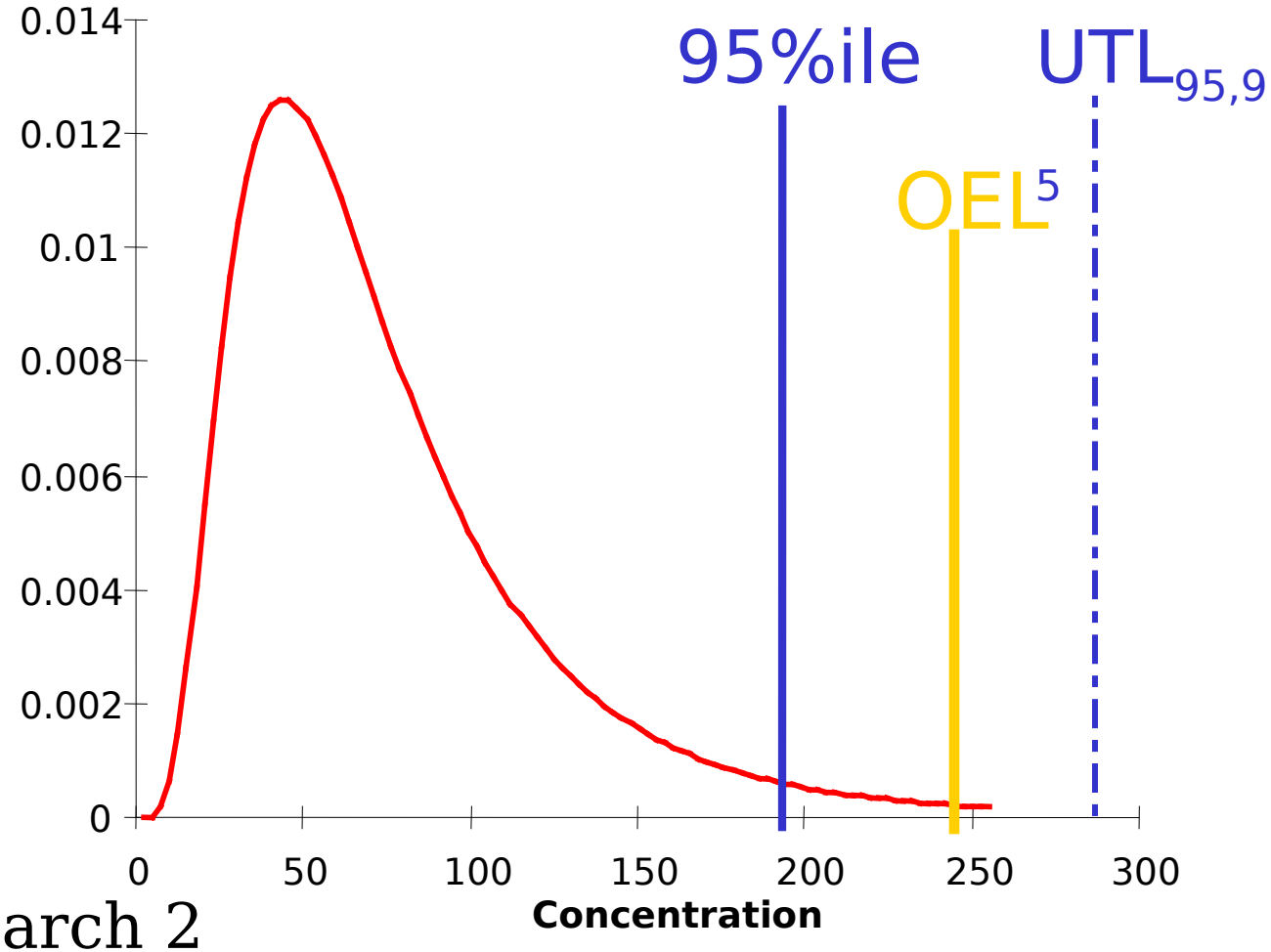
IHFOM Exposure Classifications

Unacceptable- UTL > OEL



IHFOM Exposure Classifications

Unacceptable- $UTL_{95\%,95\%}$ > OEL but 95% ile< OEL



Examples: 95th tile < OEL and UTL > OEL

Task	*Stressor*	*N*	*GM*	*Range*	*GSD*	*95th*	*OEL*	*UTL*
Sand	$SrCrO_4$*	6	0.05	0.02-0.16	2.1	0.18	0.5	0.9
Sand	Total Dust	6	0.5	0.17-2.1	2.5	2.3	15	16.1
Roof	Asphalt	8	0.12	0.025-0.51	3.4	0.9	5	5.9
SMAW	Total Fume	6	0.82	0.4-2.7	2.0	2.6	5	10.8
SMAW	Lead*	13	3.7	0.7-22	2.9	21	50	64
Boiler	Cobalt*	6	3.3	1.5-15	2.7	17	50	130
Boiler	Coal dust	6	0.26	0.1-1.3	2.3	1.1	2	6.1

* - UG

Calculation of 95th Percentile and UTL 95,95

$$UTL_{95,95} = \exp\left(\bar{y} + K \times s_y\right)$$

$$95th\ Percentile = \exp\left(\bar{y} + Z \times s_y\right)$$

$\bar{y}$ = mean

s_y = standard deviation

Z = standard normal variable

K = factor for tolerance limits

Tolerance Limits

- Tuggle, R. M. : “Assessment of Occupational exposure using one-sided tolerance limits” *Am. Ind. Hyg. Assoc. J* (43) 338-346 (1982)
  - Proposed EA scheme using $UTL_{95\%,95\%}$
  - Proposed how to proceed when $UTL_{95\%,95\%}$ > OEL but 95% ile< OEL

Comparison of Z and K

- *Z*
  - 95th percentile=1.645
- *K*
  - Depends on sample size
  - N = 4; K = 7.655
  - N = 6; K = 3.707
  - N = 9; K = 3.031
  - N=10; K = 2.911
  - N=50; K = 2.065

Test Statistic

$$UTL = \exp\left(\bar{y} + K \times s_y\right) > OEL$$

$$TS = \frac{\ln(OEL) - \bar{y}}{s_y}$$

if TS > K then SEG is acceptable

if TS < K but > Z then SEG is Future Acceptab

Test Statistic represents how many sample standard deviations the sample mean is from the OEL

Comparison of Z to K

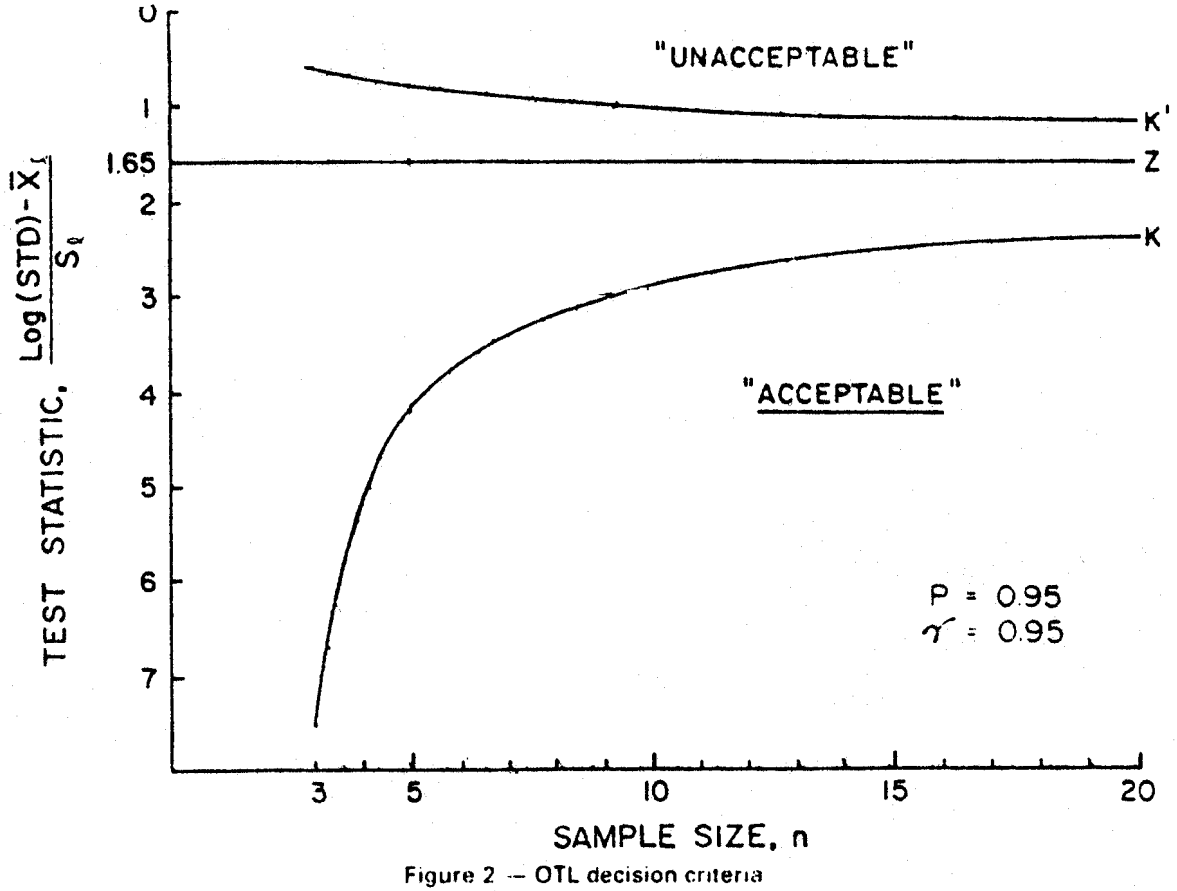


Figure 2 -- OTL decision criteria

"Test Statistic" represents how many sample standard deviations the sample mean is from the OEL

Tuggle, R. M. : "Assessment of Occupational exposure using one-sided tolerance limits" *Am. Ind. Hyg. Assoc. J* (43) 338-346 (1982)

Decision Criteria

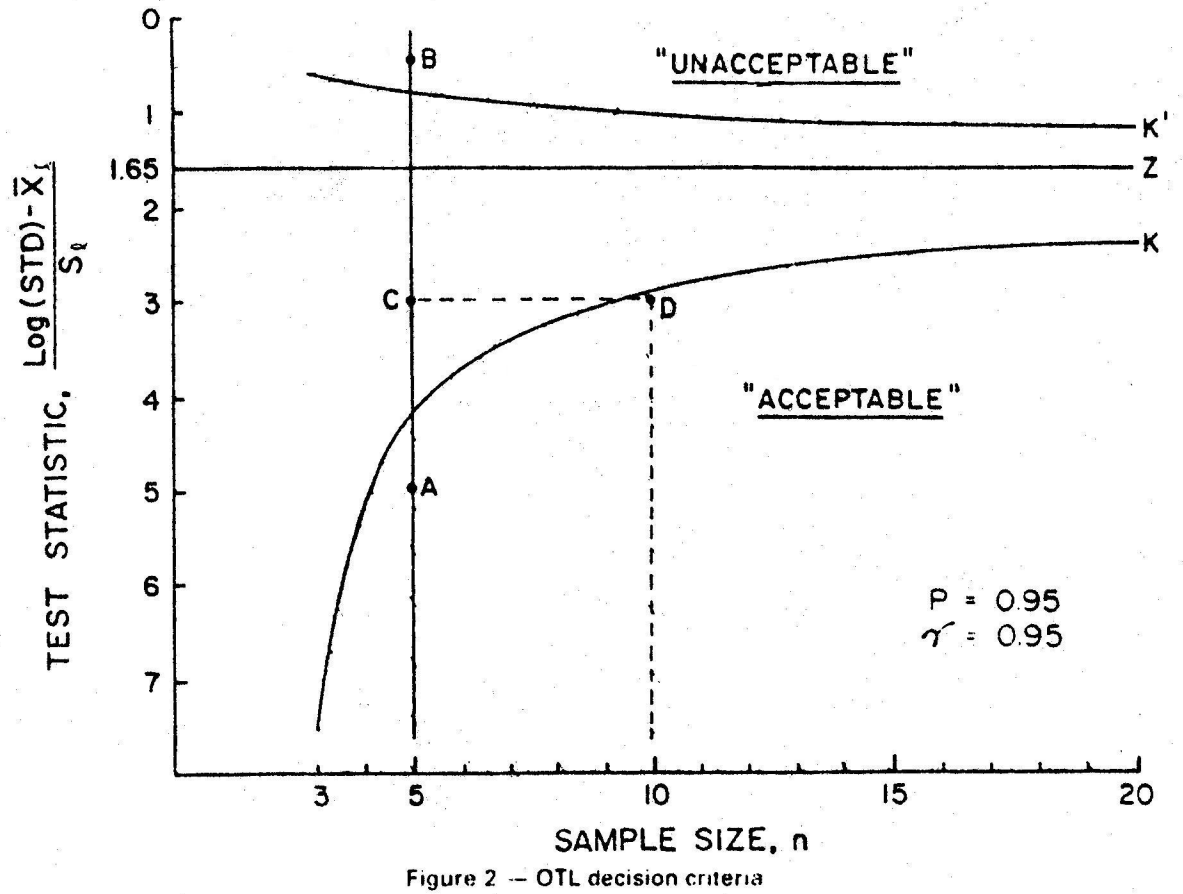


Figure 2 — OTL decision criteria

A- Acceptable

B- Unacceptable

C- Future Acceptable

D- Acceptable

Tuggle, R. M. : "Assessment of Occupational exposure using one-sided tolerance limits" *Am. Ind. Hyg. Assoc. J* (43) 338-346 (1982)

One Side Tolerance Limits Decision Scheme

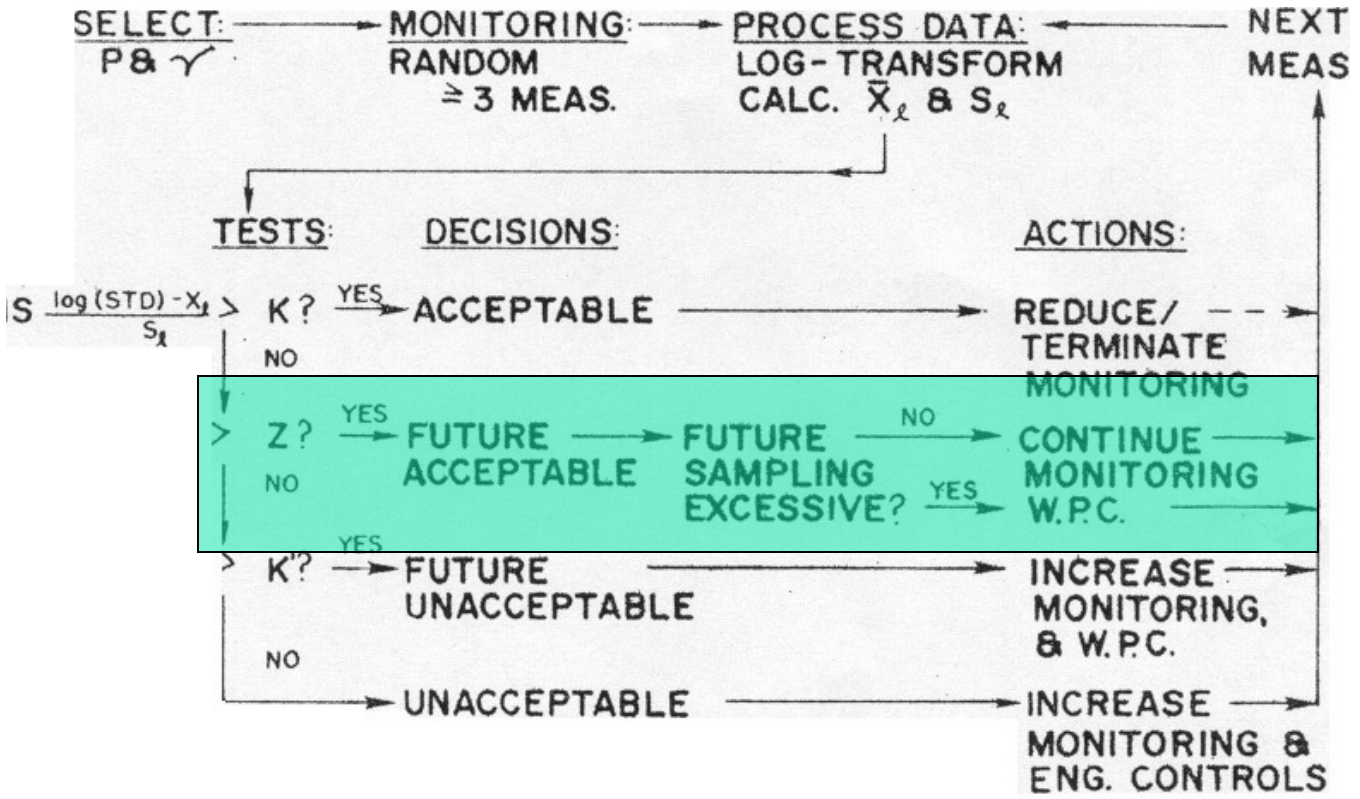


Figure 3 **Proposed OTL decision scheme.**

Tuggle, R. M. : "Assessment of Occupational exposure using one-sided tolerance limits" *Am. Ind. Hyg. Assoc. J* (43) 338-346 (1982)

How many more samples?

- Sanding $SrCrO_4$
- OEL= 0.5
- N=6
- GM=0.05
- GSD=2.119
- 95th =0.18
- UTL=0.9

$$When \ \frac{\ln(OEL) - \bar{y}}{s_y} > K \ Then \ SEG \ is \ OK$$

$$\frac{-0.693 - (-2.996)}{0.751} > K$$

$$3.06 > K$$

$$n\,more = 3$$

N = 9; K = 3.031

N =10; K = 2.911

N=50; K = 2.065

Applied to all examples

Task	*Stressor*	*OEL*	*N*	*GM*	*GSD*	*95th*	*UTL*	*N more*
Sand	$SrCrO_4$*	0.5	6	0.05	2.1	0.18	0.9	3
Sand	Total Dust	15	6	0.5	2.5	2.3	16.1	1
Roof	Asphalt	5	8	0.12	3.4	0.9	5.9	1
SMAW	Total Fume	5	6	0.82	2.0	2.6	10.8	40
SMAW	Lead*	50	13	3.7	2.9	21	64	6
Boiler	Cobalt*	50	6	3.3	2.7	17	130	6
Boiler	Coal dust	2	6	0.26	2.3	1.1	6.1	15

* = ug

Suggestions

- Use 95th %ile as decision point
- Use UTL as a measure of certainty in point estimate
- When 95th%ile <OEL and UTL > OEL
  - Base decision on 95th percentile rather than UTL and classify as acceptable
  - Determine how many samples to get TS>K
    - If reasonable consider obtaining the samples
- Use of UTL may require more than 6-10 samples